Geostationary Operational Environmental Satellite (GOES)

GOES-R Series

Solar Imaging Suite (SIS)

Unique Instrument Interface Document (UIID)

October 11, 2005

National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

To verify the correct version of this document, please contact the GOES R Series Requirements Management Office on 301-286-7898

Document Change Record

ECR #	Title	Section #	Approved	Document Date
1	SIS SPP Off Pointing Capability	3.3.4.2	2/15/05	2/22/05
10A	SIS SpaceWire Data Rate	5.2	07/25/05	2/22/05
17	SIS UIID Alignment and Attitude Error Requirement Relocation	3.3.8, 3.3.9	8/12/05	2/22/05
CCR 125	SIS – Spacecraft Interface Pointing Requirements	3.3.9	10/11/05	10/11/05

Table of Contents

1 Scope

The purpose of this Unique Instrument Interface Document (UIID) is two-fold. The first is to allocate GOES-R series spacecraft resources to the Solar Imaging Suite (SIS). The second is to serve as a core building block on which the SIS-spacecraft interface can be designed. The spacecraft integrating contractor and the SIS contractor **shall** meet each of their respective interface requirements as defined in this document.

The Government **will** be the system integrator until a system performance contractor or spacecraft contractor with that responsibility is selected. Until that time, the Government **will** be responsible for accommodation trades, resource allocation (weight, power, space, bandwidth, etc.), and resolving interface issues. This UIID **will** govern the development of an Interface Control Document (ICD). The ICD development **will** be a joint activity of the SIS and spacecraft contractors.

The SIS ICD establishes the details of the electrical, communications, mechanical, thermal, integration and test, and command and data handling (C&DH) interfaces between the SIS instrument and the GOES-R spacecraft. After the ICD is signed and approved by all parties, the spacecraft contractor **shall** maintain the ICD.

The SIS consists of the Solar X-ray imager (SXI), the solar X-ray sensor (XRS), and an extreme ultraviolet sensor (EUVS). This instrument suite requires primary power and command input data from the spacecraft. Instrument output data to the spacecraft contains instrument information, instrument telemetry and ancillary data.

1.1 Document Overview

Together, the General Interface Requirements Document (GIRD) and the SIS UIID establish the SIS spacecraft interface requirements. The GIRD applies to all GOES-R instruments while the SIS UIID is specific to the SIS. Section 1 explains the use of this document. Section 2 lists reference documents. Section 3 allocates spacecraft resources, such as mass, power, and data rate, to the SIS instrument Suite. Section 4 contains government-accepted operation constraints. Section 5 contains government-accepted deviations from the GIRD. Section 6 contains a list of acronyms used within this document.

1.2 Mission Requirements

The term "(TBD)", which means "to be determined", applied to a missing requirement means that the instrument contractor determines the missing requirement in coordination with the spacecraft contractor.

The term "(TBR)", which means "to be refined/reviewed", means that the requirement is subject to review for appropriateness by both contractors , and subject to revision. Both the spacecraft and instrument contractors are liable for compliance with the requirement as if the "TBR" notation did not exist. The "TBR" merely provides an indication that the value is more likely to change in a future modification than requirements not accompanied by a "TBR".

1.3 Order of Precedence

The order of precedence of interface requirements documents is the UIID at the highest level,

followed in order by the GIRD, ICD, and IDD.

2 Reserved

3 Allocations

The GOES-R spacecraft **shall** provide communications, power and a Sun-Pointing Platform (SPP) for the SIS instruments throughout the entire mission. The following paragraphs allocate these resources to SIS.

3.1 Command and Data Handling

3.1.1 Instrument-to-Spacecraft Science Volume

The instrument science and engineering data rate, including all overhead associated with Consultative Committee for Space Data Systems (CCSDS) packetization by the instrument at the spacecraft interface, **shall** not exceed 2.8 million (10^6) bits per second when averaged over any 5 second period.

3.1.2 Telemetry Data Rate

Housekeeping telemetry data rate, including all overhead associated with Consultative Committee for Space Data Systems (CCSDS) packetization by the instrument at the spacecraft interface, **shall** not exceed 1024 bits per second, when averaged over any 5 second period.

3.1.3 Application Process Identifiers

The SIS **shall** use no more than 63 consecutive APIDs for science, telemetry, and command packets.

3.1.4 Advance Notice of Change In Sun-Pointing Platform (SPP) Position

The spacecraft **shall** provide the SIS an advance notice, in the ancillary data packet, of a change in the SPP position.
The spacecraft **shall** send the notice at least 100 milliseconds prior to the initiation of the change. (TBR)

3.1.5 Spacecraft Telemetry Required for SIS Data Processing

Spacecraft telemetry required to analyze SIS data **shall** be provided to the SIS ground system whenever SIS data are available. The spacecraft data that are required to analyze the SIS data includes the ephemeris, spacecraft attitude, flags to indicate the occurrence of any East-West or North-South maneuver for the SPP, and the SPP pointing data (TBR).

3.1.6 SIS Sun-Pointing Data to Spacecraft

The SIS **shall** send SIS Sun-pointing data to the spacecraft in a CCSDS source packet per the Command and Data Handling section of the GIRD.

3.2 Power

3.2.1 Average Power

The SIS **shall** draw no more than 130 Watts (TBR) averaged over five (5) minutes (TBR).

3.2.2 Peak Power

The SIS total peak power input including heaters **shall** be no more than 135Watts (TBR) over 30 seconds (TBR).

3.2.3 Survival Power

When the instrument is OFF, the instrument survival heaters shall consume no more than 45W (TBR) averaged over every 72 (TBR) minute period.

3.3 Mechanical

The requirements in this section apply to the structural and mechanical components of the instrument flight units.

3.3.1 Mass Properties

The SIS, including all units, mounting hardware, thermal blankets and cabling between units, **shall** have mass less than 60 kilograms (kg) (TBR).

3.3.2 Volume

The SIS, including all units, mounts, thermal blankets and connectors for both stowed and operational configurations, **shall** have dimensions that do not exceed the limits listed in the Instrument Unit Envelopes table. The envelope for the sensor unit articulates with the Sun Pointing Platform (SPP). For the sensor unit, height is in the Y direction of the SPP Coordinate Frame (SCF) defined in the GIRD. Width is measured in the Z direction of the SCF, and depth is in the X direction of the SCF. For the electronic units, height is in the direction normal to the mechanical interface plane.

Instrument Unit Envelopes (TBR)

Unit	Height (cm)	Width (cm)	Depth (cm)
Sensor	48	31	86
Electronics one	10	30	30
Electronics two	10	30	30

3.3.3 Fields of View

The SIS instruments **shall** have the following unobstructed fields of view, free of glint from the spacecraft:

3.3.3.1 SIS Instruments View of the Sun

The SIS instruments **shall** have the following continual unobstructed Fields of View.

3.3.3.1.1 Solar X-Ray Imager View of Sun

The Solar X-Ray Imager **shall** have continual unobstructed 56.5 (TBR) arcmin full-width East-West view and 56.5 (TBR) full-width arcmin North-South view of the Sun, and centered at the Sun, during normal operational periods.

3.3.3.1.2 X-Ray Sensor View of Sun

The X-Ray Sensor **shall** have continual unobstructed 40 (TBR) arcmin full-width East-West view and 40 (TBR) full-width arcmin North-South view of the Sun, and centered at the Sun, during normal operational periods.

3.3.3.1.3 Extreme Ultraviolet Sensor View of the Sun

The Extreme Ultraviolet Sensor **shall** have continual unobstructed 40 (TBR) arcmin full-width East-West view and 40 (TBR) full-width arcmin North-South view of the Sun, and centered at the Sun, during normal operational periods.

3.3.3.2 SIS Instruments Off-Sun Field of View

The SIS instruments **shall** be the following unobstructed off-Sun Fields of View for calibration:

3.3.3.2.1 Solar X-Ray Imager Off-Sun Field of View

The Solar X-Ray Imager **shall** have an unobstructed 56.5 arcmin radius full circle field of view centered at least 90 arcmin from the center of the Sun to support off-Sun-pointing for calibration.

3.3.3.2.2 X-Ray Sensor Off-Sun Field of View

The X-Ray Sensor **shall** have an unobstructed 40 arcmin radius full circle field of view centered at least 15 degrees (TBR) from the center of the Sun to support off-Sun-pointing for calibration.

3.3.3.2.3 Extreme Ultraviolet Sensor Off-Sun Field of View

The Extreme Ultraviolet sensor **shall** have an unobstructed 40 arcmin radius full circle field of view centered at least 15 degrees (TBR) from the center of the Sun to support off-Sun-pointing for calibration.

3.3.4 Sun Pointing Platform (SPP)

The spacecraft **shall** provide a Sun-Pointing Platform (SPP) for mounting the SIS on the spacecraft.

3.3.4.1 Sun Pointing Platform (SPP) Slew

The spacecraft design **shall** allow for the slewing of the SPP in each of N-S and E-W directions from the Sun center with a 1.5 degree amplitude, to support SXI flat-field measurements. Slewing in the North-South direction will not be required during the 45 days centered on one of the solstices.
The spacecraft **shall** initiate, upon command, a sequence of five 3-degree slews about the N-S (E-W) axis followed by five 3-degree slews about the E-W (N-S) axis, with both slews centered on the Sun.

The slew sequence transverses between +1.5 degrees and -1.5 degrees in each of the N-S and E-W axes five times at a constant rate, returning to Sun center after the completion of the sequence.
The nominal slew rate **shall** be at least 0.1 degree per second.
The variation in the slew rate **shall** be limited to +/-20% of the nominal slew rate.

3.3.4.2 Spacecraft Off-Sun-Pointing of Sun Pointing Platform (SSP)

The spacecraft **shall** have the capability of pointing the SPP a minimum of 15 degrees (TBR) for off-sun calibration of the SIS instruments. *(ECR 0001)*

3.3.4.3 Sun-Pointing Platform (SPP) Pointing Control

The spacecraft **shall** provide N-S maneuver of the SPP in increments of no greater than is 15 arcsec.

3.3.5 SIS Mounting Panel

The SIS Mounting Panel **shall** be provided by the SIS contractor as the "instrument side" of the SIS/spacecraft interface.
The XRS, EUVS and SXI **shall** be mounted and co-aligned on the SIS mounting panel.

3.3.6 Thermal Interface

3.3.6.1 Conduction

The SIS Mounting panel / SPP interface **shall** be thermally isolated with mounting hardware/materials provided by the Spacecraft contractor. The spacecraft mechanical attachment shall have the following temperature range: -20 °C to 50 °C (TBR) and as cold as -90C at the end of eclipse. Wire bundles leading away from the SIS mounting panel shall be subjected to this temperature range.

3.3.6.2 Radiation Interface/Environment

The following table defines the thermal fluxes for four sides of the instrument:

	IR Energy		Solar Energy (Direct and Reflected)	
	Cold/Minimum watts/m^2	Hot/Maximum watts/m^2	Cold/Minimum watts/m^2	Hot/Maximum watts/m^2
Telescope facing the Solar Array ($+Y_{SIS}$)	60	70	10	15
Telescope facing Spacecraft ($-Y_{SIS}$)	40	200	10	100
Sun Side ($+X_{SIS}$)	0	60	1270	1440
Anti-sun Side ($-X_{SIS}$)	0	80	0	70

Notes:
For initial analysis and trade studies, the periphery of the instrument telescope facing between the two extremes (facing toward and facing away from the spacecraft) can be interpolated between the listed values.
The “solar” energy includes direct plus any solar energy reflected from the spacecraft. Solar flux

table inputs ignores eclipses. The "IR" energy is thermal energy radiated from spacecraft surfaces. Assume Earth "IR" is zero for non-cryogenic radiators .

3.3.6.3 Thermal Interface - Thruster Plume Heat Flux

The maximum plume heat flux onto any SIS surface **shall** not exceed 386 w/m^2 (TBR).

3.3.7 Cabling Between Units

The maximum length of the harness cables between units **shall** not exceed 1 meter.
Cables running to the sensor unit **shall** withstand its articulation for deployment and north-south solar tracking.

3.3.8 Solar Imaging Suite (SIS) Alignment *ECR 0017*

3.3.8.1 References *ECR 0017*

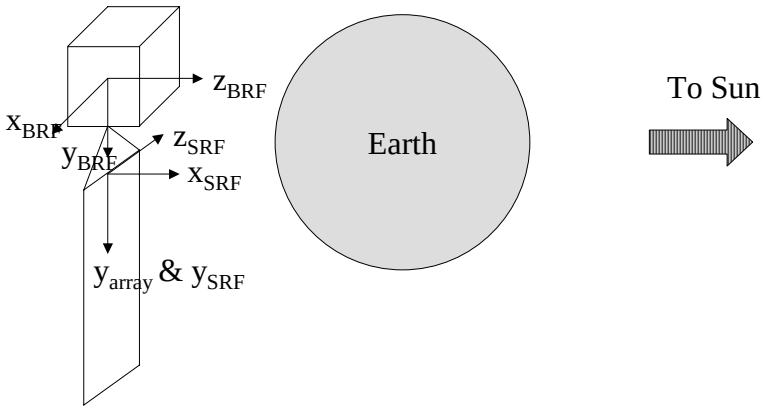
The SIS **shall** include a permanent alignment reference on the SIS unit composed of a minimum 2.54 cm alignment cube and a mounting surface datum. The SIS Alignment Reference Frame (SARF) is a right-handed coordinate frame attached to the SIS alignment cube such that its X-axis nominally points to the Sun and the Z- axis represents the elevation axis for pointing to the Sun. The Y-axis completes the right-handed triad. *ECR 0017*
The spacecraft Sun-Pointing Platform (SPP) **shall** include an alignment cube mounted on the SPP. A right-handed coordinate frame, called the SPP Coordinate Frame (SCF), is attached to this alignment cube. The SARF and SCF represent coordinate frames that are nominally parallel to each other. The X-axis of SCF nominally points to the center of the Sun. The elevation degree of freedom for the SCF to point to the Sun is provided by articulating the SPP about the Z-axis of the SCF. The Y-axis of the SCF completes the right-handed triad. *ECR 0017*
The SPP and SIS alignment cube pairs **shall** be viewable from two orthogonal directions during the integration of the SIS with the Sun-Pointing Platform. *ECR 0017*
The SIS contractor will document the locations of all instrument optical alignment cubes in the IDD. *ECR 0017*
The SIS Reference Frame (SRF) is defined as follows: The SIS X-axis points along the bore sight of the SXI and is normal to the SIS YZ-plane. The SIS YZ-plane nominally contains the SXI detector focal plane and the SIS Z-axis is nominally parallel to the SXI detector readout axis and the SPP articulation axis. In addition, the axes of the SIS Reference Frame are nominally parallel to those of the SARF. *ECR 0017*

3.3.8.2 Responsibilities *ECR 0017*

The spacecraft contractor will align the SARF to the SCF. *ECR 0017*
The spacecraft contractor will conduct analyses required to allocate the flow-down budget for the alignment between the SARF and the SCF. *ECR 0017*
The spacecraft contractor will measure the alignment between the SARF and the SCF. *ECR 0017*
The spacecraft contractor is responsible for providing the alignment knowledge of the SARF with respect to the Body Reference Frame (BRF). *ECR 0017*

3.3.8.3 Placement *ECR 0017*

For the configuration of the spacecraft and SIS at the spacecraft local midnight at equinox (See Figure below) when the SCF YZ plane is nominally parallel to the BRF XY-plane, the placement of the SCF Y- and Z-axes **shall** be within 0.3^{o} of the BRF Y- and X-axes, respectively, including variation over all launch and on-orbit environments. *ECR 0017*



Spacecraft & SIS Configuration at local midnight at equinox

ECR 0017

3.3.8.4 Initial Alignment Knowledge *ECR 0017*

The prelaunch alignment knowledge of the Sun-Pointing Platform alignment reference frame with respect to the spacecraft IRU input axes **shall** be TBD microradians or better, per axis. *ECR 0017*

3.3.8.5 Alignment Rate of Change *ECR 0017*

The rate of change of the alignment of the Sun-Pointing Platform alignment reference frame with respect to the spacecraft IRU input axes shall not exceed TBD microradians per hour per axis. This requirement includes on-orbit environments and spacecraft structural and thermal stability. *ECR 0017*

3.3.9 Attitude Errors and Disturbances for SIS *ECR 0017*

The requirements in this section apply during SIS imaging periods while all the instruments and mechanisms on-board the spacecraft in-orbit are operating. *ECR 0017*
The North-South and East-West directions correspond to the elevation and azimuth directions, respectively, of the center of the Sun when viewed from the Sun-Pointing Platform. In the figure "Spacecraft & SIS configuration at mid-night at equinox," the West and South directions are along $+Z_{SRF}$ and $+Y_{SRF}$ axes, respectively. The E-W and N-S pointing control is required to maintain observations of the solar disk and off-limb phenomena within the FOV of the SIS instruments. *ECR*

0017

3.3.9.1 Spacecraft-to-Instrument Disturbances *ECR 0017*

3.3.9.1.1 Sun-Pointing Platform Attitude Error and Stability *ECR 0017*

3.3.9.1.1.1 Operational Sun-pointing Time *CCR 00125*

Operational Sun-pointing Time is any on-orbit normal operational period that does not include spacecraft housekeeping, stationkeeping, station changes greater than one degree per day, and eclipse. *CCR 00125*

3.3.9.1.1.2 Sun-Pointing Accuracy *CCR 00125*

The spacecraft shall point the center of the SXI boresight to within +/-1.5 arcminutes, 3-sigma, of the center of the Sun in each of the E-W and N-S axes of the SXI boresight during the Operational Sun-pointing Time. *CCR 00125*

3.3.9.1.1.3 Sun-Pointing Stability *CCR 00125*

The Sun-pointing jitter during any consecutive 60-second period of Operational Sun-pointing Time shall be less than +/-6.0 arcseconds, 3-sigma. *CCR 00125*

3.3.9.1.2 Sun-pointing Attitude Knowledge *ECR 0017*

The spacecraft-provided knowledge of the Sun-pointing error of the Sun-Pointing Platform shall not exceed 10 arc-seconds (TBR). *ECR 0017*

3.3.9.1.3 East-West and North-South Bias-pointing *ECR 0017*

The spacecraft **shall** provide a ground-commandable bias-pointing capability for the SPP in each of the East-West and North-South directions. *ECR 0017*
The bias range shall be at least ± 40 arc-minutes about the Sun line, in one arc-minute or smaller increments. *ECR 0017*
The East-West and North-South bias pointing accuracy requirements shall be the same for the non-bias pointing in Section titled Sun-Pointing Platform Attitude Error and Stability. *ECR 0017*

3.3.9.2 Instrument-to-Spacecraft Disturbances *ECR 0017*

3.3.9.2.1 Instrument Disturbance Torque Limits *ECR 0017*

At any time during the operational mode of the spacecraft, the sum of the magnitude of the instrument suite's uncompensated torques and the magnitude of its uncompensated linear forces multiplied by a lever arm of 2 meters **shall** not exceed 0.2 (TBR) N-m. *ECR 0017*
The instrument suite's uncompensated torque vs. time characteristic **shall** be shaped so as to minimize the excitation of the flexible modes of vibration of the spacecraft. *ECR 0017*

3.3.9.2.2 Instrument Allowable Angular Momentum *ECR 0017*

The magnitude of the instrument suite's uncompensated angular momentum **shall** not exceed 0.1 (TBR) N-m-sec. *ECR 0017*
The instrument contractor will document the angular momentum produced by the instrument in the IDD. *ECR 0017*

4 Constraints

In order to ensure proper instrument performance or to prevent possible instrument damage, the following Government-approved constraints are imposed by the instrument developer on spacecraft integration and test activities, including launch, activation and operations. No constraints have been identified at this time.

5 GIRD Deviations

This section identifies General Instrument Requirements Document (GIRD) requirements that the government has deviated from for this instrument. Where appropriate, corresponding GIRD paragraph titles and numbers are identified in parentheses.

5.1 Molecular Contamination

(3.5.2.2.2 Molecular Contamination GIRD834)
The spacecraft shall contribute no more than 9 µg/cm^2 nonvolatile residue to instrument thermal control surface apertures, and the instrument optical aperture over the life of the spacecraft.

5.2 SpaceWire Data Rate

(GIRD requirement GIRD441 in Section 3.2.5.5, SpaceWire Data Rate, is not applicable to the SIS instrument and is superceded by the following requirement)

Data transferred over the SpaceWire data bus shall be clocked at 10 MHz. (TBR)

Note: This clock rate allows for an 8 Mbps data rate accounting for SpaceWire overhead. *(ECR 0010A)*

6 Acronyms and Abbreviations

APID	Application Process Identifiers
C&DH	Command and Data Handling
CCSDS	Consultative Commitee for Space Data Systems
CCN	Contract Change Notice
cucm	Cubic Centimeters
dB	deci-Bell(s)
EUVS	Extreme Ultraviolet Sensor
GIRD	General Interface Requirements Document
GOES	Geostationary Operational Environmental Satellite
GSFC	Goddard Space Flight Center
Hz	Hertz
ICD	Interface Control Document
IDD	Instrument Description Documents
INR	Image Navigation and Registration
kg	kilogram(s)
m	meter(s)
m-g	milli-g's (Earth's gravitational acceleration)
MHz	Megahertz
N	Newtons (unit of force)
NASA	National Aeronautics and Space Administration
PORD	Performance and Operations Requirements Document
sec	second(s)
SIS	Solar Imaging Suite
SPP	Sun-pointing Platform
TBD	To Be Determined
TBR	To Be Reviewed
TBS	To Be Specified
µg	microgram
UIID	Unique Instrument Interface Document
W	Watts
XRS	X-Ray Sensor